

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: JESSE J. WILLIAMS, ERIC J. HANSEN, AND LINDSAY M. ULMAN

For: MANUAL SPRAY CLEANER

Serial No.: 10/604,780

Examiner: Lorna M. Douyon

Filed: 08/15/2003

Art Unit: 1744

Docket: 71189-1501

DECLARATION UNDER 37 CFR § 1.132 OF WILLIAM STEPHEN TAIT, PHD

William Stephen Tait, PH.D. declares that;

1. I am a citizen of the United States and a resident of Madison, Wisconsin. My Curriculum Vitae is attached hereto as Exhibit A.
2. I was awarded a BA in Chemistry from the University of Missouri-St. Louis in 1972. I was awarded a MS degree in Chemical Engineering from Sever Institute, Washington University, St. Louis, Missouri in 1977. I was awarded a PhD in Materials Engineering from the University of Wisconsin-Milwaukee in 1988. My area of specialty for my study and dissertation for my PH.D was corrosion and surface science with a minor in statistics.
3. I am presently employed as the Chief Science Officer and Principle Consultant in Pair O Docs Professionals L.L.C. in Madison, Wisconsin and have been so employed since July 2000. My consulting work has been principally in the field of corrosion of metals and coated metals and, in particular, in the field of corrosion in aerosol containers. Between the years 1978 and July 2000, I was employed as a Senior Research Associate and Lab Group Leader by S.C. Johnson & Son, Inc. in Racine, Wisconsin. My work at S.C. Johnson consisted of managing the corrosion and metal package laboratory. This laboratory was responsible for qualifying all types of metal packages for use with aerosol and non-aerosol consumer and commercial products.

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4. I have taught a number of courses on corrosion of metals at the University of Wisconsin-Milwaukee; was an Adjunct Professor between April 2000 and April 2003 and as an Adjunct Associate Professor between March 1991 and April 1997. In addition, I have taught short courses in corrosion testing, coatings and aerosol container corrosion as a consultant plus presented technical papers at professional symposia, including:

- *The Elements of Aerosol Container Corrosion*, presented by Pair O Docs Professionals (May 2004; October 2004; October 2005; and October 2006).
- *Introduction to Corrosion; Basic Concepts of Corrosion; Corrosion Testing and Monitoring; Corrosion Environments*, ASM International Course Lessons 1, 2, 8, and 12, Milwaukee, Wisconsin (February 4, 2004 and March 10, 2004).
- *The Basics of Aerosol Container Corrosion*: Pair O Docs Professionals short course Madison, Wisconsin (May 2003).
- *A Practical, Helpful, and Personalize Introduction to Corrosion Testing Methods on Coated Metals*: Pair O Docs Professionals and Solartron, Inc., short course, Kohler, Wisconsin, October 13-15, 1999.
- *A Practical, Helpful, and Personalized Introduction to Corrosion Testing Methods on Uncoated Metals*: Pair O Docs Professionals and Solartron, Inc., short course, Kohler, Wisconsin, October 25-27, 1998.

5. In addition, I have written extensively and made presentations on predicting results from static storage tests on internally coated metal containers. Included in my presentations at professional society meetings and conferences are:

- "Elements of a Comprehensive Aerosol Container Corrosion Prevention and Control Program," presented to the Eastern Aerosol Association in Newark, New Jersey in October 2006, to the Latin American Aerosol Conference, Buenos Aires, Argentina in September 2006, to the Southern Aerosol Technical Association, Atlanta, Georgia in March 2006, and to the Midwest Aerosol Association, Chicago, Illinois in April 2006.
- "Aerosol Container Corrosion Prevention, Control and Measurement," presented at SATA technical conference, Destin, Florida on October 5, 2001,

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- "An Introduction to Aerosol Container Corrosion, Corrosion Prevention and Control," presented at CSPA Workshop Aerosol Technology Workshop, Washington, D.C. on April 18-20, 2001.

6. From December 2002 to the present, I have written the monthly column *Corrosion Corner*, published in the Spray Technology and Marketing Magazine, Industry Publications, Parsippany, New Jersey.

7. As enumerated in my Curriculum Vitae, I have also written articles that have been published in books and periodicals, peer reviewed journals and proceedings and non-peer reviewed journals, all in the field of corrosion of metals and coated metals, and especially in the field of corrosion in aerosol containers for at least the last 29 years.

8. I am one of eighteen corrosion specialists in the world who are certified as a chemical treatment specialist (development of corrosion inhibitors) by NACE International (formerly the National Association of Corrosion Engineers). In addition, I have numerous professional society memberships and activities in professional societies, all with respect to corrosion technologies, including an emphasis on corrosion in aerosol containers, as set forth on my Curriculum Vitae.

9. I have 7 U.S. patents for corrosion inhibitors; corrosion test equipment; and a device for crevice corrosion testing.

10. As a result of my education, experience, and publications as set forth above and as set forth in my Curriculum Vitae, I believe that I am qualified as an expert in the field of corrosion in aerosol containers.

11. I have been retained by Bissell Homecare, Inc. to serve as an expert in the prosecution of the above identified patent application (the Bissell patent application), which I understand is assigned to Bissell Homecare, Inc. In the course of my normal consulting work, I have previously been retained as a consultant for BISSELL Homecare Inc. during the period of May,

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2007 through June, 2007 for corrosion testing on a new aerosol product. I am not otherwise subject to a retainer and do not otherwise serve as a consultant to BISSELL Homecare, Inc.

12. In the course of my preparation for this Declaration, I studied the Bissell patent application, the rejected claims in the Bissell patent application, the Gross et al. U.S. Patent 6,824,623 (Gross et al. '623) and the Wilkins et al. U.S. Patent No. 5,215,675 (Wilkins et al. '675) in the Office Action in this application, mailed April 17, 2007 (the Office Action).

13. It is my understanding that claim 49 in the BISSELL patent application has been rejected over the Wilkins et al. '675 reference in view of the Gross et al. '623 references in the Office Action. It is also my understanding that the Examiner Douyon, the Examiner in charge of the BISSELL patent application, believes that the corrosion test disclosed in the Wilkins et al. '675 patent would lead an ordinary worker in the aerosol packaging field to believe that the stripping composition of Wilkins et al. '675 could be packaged with an aerosol propellant in aerosol cans made from a bare aluminum in view of the teaching of the Gross et al. '623 which discloses that graffiti remover, paint stripper and degreaser compositions can be packaged in a variety of containers such as steel, tin, and aluminum cans and can be applied by spraying such as in aerosol form. I disagree with the Examiner's position as to her conclusion with respect to claim 49 because I do not believe that the disclosure in the Wilkins et al. '675 reference would lead an ordinary worker skilled in the art of aerosol packaging to believe that a peroxide aerosol composition could be packaged in a bare aluminum aerosol can. The reasons for my conclusions follow.

14. As I understand it, claim 49 in the BISSELL patent application relates to a manual spray cleaner for removing dirt and stains and comprises a peroxide composition and a propellant that is packaged in an uncoated aluminum container.

15. The Wilkins et al. '675 patent discloses a stripping composition that includes hydrogen peroxide for stripping paint and resin from an aircraft aluminum alloy surface and a corrosion

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test for testing the corrosiveness of the stripping composition on the aluminum alloy 2024 (UNS # A92024) in the area under the overlap between two separate pieces of sheet metal. This test simulates crevice corrosion of aircraft exteriors that use 2024 aluminum alloy. I am quite familiar with aluminum alloy 2024 and the tests performed by Wilkins et al. The Wilkins et al. corrosion test is a simulated atmospheric test in which the relative humidity in a chamber is cycled between high and low magnitudes at one atmospheric pressure. 2024 aluminum has a 3.8 to 4.9% copper content specification and is typically used in aircraft exterior panels.

16. The Gross et al. '623 reference discloses a graffiti remover, paint stripper and degreaser that includes an oil-soluble anionic surfactant, a water-soluble anionic surfactant, a primary solvent consisting of C_{1-4} alkyl ester, a short-chain cosurfactant, and water. Gross et al. is concerned about the possibility of corrosion in the packaging of the Gross et al. composition in lined steel cans, and in particular, lined aerosol cans.

17. Wilkins et al. does not teach an ordinary worker in the aerosol packaging field that packaging of the Wilkins et al. hydrogen peroxide stripping composition with an aerosol propellant in a bare aluminum aerosol container would likely be free of unacceptable corrosion. The tests to determine the corrosion resistance of a particular aerosol composition in an aerosol can are remarkably different from the test performed by Wilkins et al. for the 2024 aluminum alloy. Whereas the Wilkins et al. test simulated an atmospheric test in which the relative humidity in a chamber is cycled between high and low magnitudes at one atmospheric pressure, the surface inside an aerosol container is continuously exposed to a liquid mixture and a small area at the top of the aerosol container is continually exposed to a gas mixture of propellant and other formula ingredients at an elevated pressure. Whereas the Wilkins et al. test is performed at one atmospheric pressure, aerosol containers are under pressures of two or more atmospheres. Thus, the Wilkins et al. cyclic test does not simulate the continuous exposure of the Bissell composition inside bare aluminum containers under two or more atmospheric pressures.

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18. In addition, aluminum aerosol containers are typically formed by deep drawing of an aluminum puck and thus do not have crevices formed by overlapping pieces of sheet metal exposed to a liquid or gaseous media. Thus, the simulated crevice test described in Wilkins et al. does not simulate aluminum aerosol container corrosion in non-crevice areas.

19. Further, the aluminum containers are fabricated from a 1000 series aluminum (UNS #A1XXX). 1000 series aluminum has a 0.04 maximum copper content specification whereas 2024 aluminum has a 3.8 to 4.9% copper content specification. Corrosion resistances and tendencies of 2024 aluminum and 1000 series aluminum are significantly different. See, for example, NACE International Corrosion Data Survey-Metals Section, Sixth Edition, page ii (a copy of which is attached as Exhibit B). Furthermore, liquid phase corrosion, atmospheric corrosion and crevice corrosion have different mechanisms for initiation. These different mechanisms occur in different types of environments and at significantly different rates of penetration through metals. Still further, corrosion potentials and rates are determined by the type of metal and the chemical composition of the environment to which the metal is exposed. For example, aluminum corrosion is significantly faster in hydrochloric acid than in normal atmospheric conditions. See Uhlig, Corrosion and Corrosion Control, 2nd Edition, pp. 31-32, John Wiley & Sons, Inc. New York, New York (1971), attached hereto as Exhibit C, and Tait et al. Corrosion, p. 627, Volume 42 (10), October 1986, a copy of Table 3 is attached hereto as Exhibit D.

20. In summary, the corrosion test results of Wilkins et al. '675 are valid only for the specific chemical composition of the environment used to test the corrosion resistance of the specific aircraft aluminum alloy. Thus, the corrosion test results in Wilkins et al. '675 have no significant relevance for corrosion of the bare aluminum alloy used to fabricate aerosol containers.

21. Gross et al. does not disclose the packaging of the Gross et al. stripping composition in unlined aerosol containers. It is well known that corrosion of coated metals is significantly different from the corrosion of uncoated metals. In fact, coatings are put on metals to prevent

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them from corroding. Gross et al. '623 does not disclose or suggest that a peroxide composition can be packaged in an unlined aluminum aerosol container.

22. In conclusion, contrary to the holding by Examiner Douyon in the BISSELL patent application, based on my review of the documents set forth above and my expertise in the aerosol container corrosion field, I conclude that the Wilkins et al. a '675 and the Gross et al. '623 references, when considered as knowledge to an ordinary worker skilled in the art of aerosol packaging, would not have taught or suggested to an ordinary worker skilled in the art of aerosol packaging that it would have been obvious to package the stripping composition of Wilkins et al. '675 in aerosol cans made from bare aluminum. Further, in considering both of these references as a one with considerably more skill than the ordinary worker skilled in the art of aerosol packaging, the packaging of a peroxide aerosol composition in an aerosol container formed of a bare aluminum material would not be obvious to me in view of my knowledge of the Wilkins et al. '675 and the Gross et al. 623 references.

23. I have no financial interest in BISSELL Homecare, Inc. and no financial interest in the outcome of this application.

24. I hereby declare that all statements made herein of my own knowledge are true and that statements were made with the knowledge that willful, false statements and the like so made are punishable by fine or imprisonment, or both, under § 101 of title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing there from.

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Dated: 7/17/07

By William Stephen Tait
William Stephen Tait, PH.D.

G0310152

Exhibit A

WILLIAM STEPHEN TAIT, PH.D.

Pair O Docs Professionals L.L.C.

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EDUCATION

Ph.D. Materials Engineering, University of Wisconsin-Milwaukee (1988)

- ❖ Dissertation Title: Aluminum, aluminum-nitrogen alloy, and aluminum nitride coated steel corrosion behavior in oxygen-free potassium chloride solutions
- ❖ Areas of Specialty: Corrosion and Surface Science
- ❖ Minor: Statistics

M.S. Chemical Engineering, Sever Institute, Washington University, St. Louis Missouri (1977)

B.A. Chemistry, University of Missouri-St. Louis (1972)

EMPLOYMENT HISTORY

Chief Science Officer and Principle Consultant— Pair O Docs Professionals L.L.C.
Madison, Wisconsin (July 2000 to present)

Adjunct Professor - University of Wisconsin-Milwaukee
(April 2000 to April 2003)

Senior Research Associate and Lab Group Leader - S. C. Johnson & Son, Inc.
Racine Wisconsin (1978 to July 2000)

Adjunct Associate Professor - University of Wisconsin-Milwaukee
(April 1997 to January 1999)

Adjunct Assistant Professor - University of Wisconsin-Milwaukee
(March 1991 to April 1997)

Ad Hoc Lecturer - University of Wisconsin-Milwaukee
(Semester II 1982 to 1983)

Research Scientist - Petrolite Corporation, St. Louis Missouri
(1973 to 1978)

Analytical Chemist- Heun Norwood Corporation, St. Louis, Missouri
(1973)

Laboratory Instructor - University of Missouri-St. Louis Chemistry Department
(1971 to 1972)

AWARDS

University of Wisconsin – Milwaukee Advanced Coatings Experimental (ACE)
Laboratory **ACE Lab Scholar** (December 2000 – June 2001)

University of Wisconsin - Milwaukee College of Engineering and Applied Science
Outstanding Alumnus Award (1997)

Who's Who in Science and Engineering, 4th Edition

S. C. Johnson & Son, Inc. **Technical Merit Award** (1986)

TEACHING EXPERIENCE

The Elements of Aerosol Container Corrosion

Pair O Docs Professionals short course, Madison, WI (October 2006)

Pair O Docs Professionals short course, Madison, WI (October 2005)

Pair O Docs Professionals short course, Madison, WI (October 2004)

Pair O Docs Professionals short course, Madison, WI (May 2004)

Introduction to Corrosion; Basics Concepts of Corrosion; Corrosion Testing and Monitoring; Corrosive Environments

ASM International course lessons 1,2, 8 and 12, Milwaukee, WI (February 4, 2004 and March 10, 2004)

The Basics of Aerosol Container Corrosion

Pair O Docs Professionals short course, Madison, WI (May 2003)

Engineering Materials (590-201)

University of Wisconsin - Milwaukee
Milwaukee, WI (Fall Semester, 2000)

Engineering Materials (590-201)

University of Wisconsin - Milwaukee
Milwaukee, WI (Fall Semester, 1999)

A Practical, Helpful, and Personalized Introduction to Corrosion Testing Methods on Coated Metals

Pair O Docs Professionals and Solartron Inc. short course, Kohler WI (October 13 - 15, 1999)

A Practical, Helpful, and Personalized Introduction to Corrosion Testing Methods on Uncoated Metals

Pair O Docs Professionals and Solartron Inc. short course, Kohler WI (October 25 - 27, 1998)

**Electrochemical Corrosion Testing Methods for Practicing Engineers and Scientists:
Impedance Techniques**

Pair O Docs Professionals short course, Kohler, WI (October 13-15, 1999)

**Electrochemical Corrosion Testing Methods for Practicing Engineers and Scientists:
Direct Current Techniques - Part II**

Pair O Docs Professionals short course, Milwaukee, WI (October 26-28, 1999)

Principles of Corrosion Engineering and Science

Pair O Docs Professionals short course,

In-house CPE course for Harley Davidson Motors, Milwaukee WI (August 5 & 6 1999)

Kinetics of Materials Processes (590-702)

University of Wisconsin - Milwaukee

Milwaukee, WI (Winter Semester, 1999)

Principles of Corrosion Engineering and Science

Pair O Docs Professionals short course, Kohler, WI (April 19 - 21, 1999)

Engineering Materials (590-201)

University of Wisconsin - Milwaukee

Milwaukee, WI (Fall Semester, 1998)

**Electrochemical Corrosion Testing Methods for Practicing Engineers and Scientists:
Impedance Techniques**

Pair O Docs Professionals short course, Kohler, WI (November 9 - 11, 1998)

**Electrochemical Corrosion Testing Methods for Practicing Engineers and Scientists:
Direct Current Techniques - Part II**

Pair O Docs Professionals short course, Milwaukee, WI (October 26 - 28, 1998)

**A Practical, Helpful, and Personalized Introduction to Corrosion Testing Methods
on Coated Metals**

Pair O Docs Professionals and Solartron Inc. short course, Milwaukee WI (April 6 - 8, 1998)

**A Practical, Helpful, and Personalized Introduction to Corrosion Testing Methods
on Uncoated Metals**

Pair O Docs Professionals and Solartron Inc. short course, Kohler WI (April 20 - 22, 1998)

Corrosion Methodologies for Evaluating Corrosion for Coatings

Federation of Societies for Coating Technology workshop,
Atlanta GA (November 3 - 5, 1997)

Coatings for Corrosion Protection

University of Wisconsin-Madison Continuing Engineering Development
Madison, Wisconsin (July 18-20, 1994)

Corrosion Engineering in Practice

University of Wisconsin-Milwaukee Center for Continuing Engineering
Education, Chicago, Illinois (November 1-5, 1993)

Paint, Coatings, and Corrosion Prevention

University of Wisconsin-Milwaukee Center for Continuing Engineering
Education
Chicago, Illinois (May 1993)

Coatings for Corrosion Protection

University of Wisconsin-Milwaukee Center for Continuing Engineering
Education
Milwaukee, Wisconsin (Fall semesters of 1990, 1992)

Corrosion Measurement Techniques

University of Wisconsin-Milwaukee Center for Continuing Engineering
Education
Milwaukee, Wisconsin (Fall semesters of 1990, 1992)

Corrosion Engineering in Practice

University of Wisconsin-Milwaukee Center for Continuing Engineering
Education
Milwaukee, Wisconsin (Winter semesters of 1990, 1992)

Chemical Reactor Engineering (course number 590-555)

University of Wisconsin-Milwaukee, Materials Engineering Department
Milwaukee, Wisconsin (Semester II 1982, 1983)

Chemistry 3 (general chemistry lab for non-chemistry majors)

University of Missouri-St. Louis, Chemistry Department
St. Louis, Missouri (fall semester, 1970, 1971, winter semester, 1972).

Chemistry 11 (first semester general chemistry lab for chemistry majors)

University of Missouri-St. Louis, Chemistry Department
St. Louis, Missouri (fall semester, 1970).

Chemistry 12 (second semester general chemistry lab for chemistry majors)

University of Missouri-St. Louis, Chemistry Department
St. Louis, Missouri (winter semester, 1971).

Chemistry 112 (Quantitative chemical analysis lab)
University of Missouri-St. Louis, Chemistry Department
St. Louis, Missouri (winter semester, 1972).

Chemistry 262 Teaching Assistant (Quantitative chemical analysis lecture)
University of Missouri-St. Louis, Chemistry Department
St. Louis, Missouri (winter semester, 1972).

PUBLICATIONS AND PRESENTATIONS

BOOKS AND PERIODICALS

An Introduction to Electrochemical Corrosion Testing for Practicing Engineers and Scientists, Pair O Docs Publications, Racine WI (1994)

W. S. Tait, Corrosion Prevention and Control of Chemical Processing Equipment, in the **Handbook of Environmental Degradation of Materials**, Chapter 27, William Andrew Publishing, Norwich, NY (2005)

W. S. Tait, Dielectric Properties, **Desk Reference of Polymer Characterization and Analysis**, Chapter 24, Oxford University Press, Cary, NC (2003)

W. S. Tait, Reliability Engineering: The Commonality between Airplanes, Light Bulbs, and Coated Steel, **Service Life Prediction of Organic Coatings: A Systems Approach**, Chapter 12, edited by D. R. Bauer and J. W. Martin, pp. 186-197 American Chemical Society Symposium Series 722, American Chemical Society, Washington, DC (1999).

W. S. Tait, Using Reliability Statistics to Estimate Metal Container Failure Levels from Censored Tests, **Organic Coatings for Corrosion Control**, Chapter 6, edited by G. P. Bierwagen, pp. 58-68, Symposium Series 689, American Chemical Society, Washington, DC (1998).

W. S. Tait, Corrosion Corner, a monthly column published in the Spray Technology and Marketing Magazine, Industry Publications, Parsippany, NJ (December 2000 to present)

PEER-REVIEWED JOURNALS AND PROCEEDINGS

W. S. Tait, Using Electrochemical Measurements to Accurately and Quickly Estimate Coating and Polymer Film Durability, J. Coatings Technol. (July 2003)

- W. S. Tait, Reliability Engineering: The Commonality between Airplanes, Light Bulbs, and Coated Steel, **Service Life Prediction of Organic Coatings: A Systems Approach**, edited by D. R. Bauer and J. W. Martin, American Chemical Society Symposium Series 722, American Chemical Society, Washington, DC (1999).
- W. S. Tait, Using Reliability Statistics to Estimate Metal Container Failure Levels from Censored Tests, **Organic Coatings for Corrosion Control**, edited by G. P. Bierwagen, Chapter 6, pp. 58-68, Symposium Series 689, American Chemical Society, Washington, DC (1998).
- W. S. Tait, One Laboratory's Experience Using Laminated Steel for Metal Packaging, in **Environmentally Acceptable Inhibitors and Coatings**, edited by S. R. Taylor, H. S. Isaacs, and E. W. Boorman, PV 95-16, pp. 55 - 59, the Electrochemical Society, Pennington, NJ (1997)
- R. S. Lillard, J. Kruger, W. S. Tait, and P. J. Moran, Using Local Electrochemical Impedance Spectroscopy to Examine Coating Failure, *Corrosion*, **51**(4), pp. 251-259 (1995)
- W. S. Tait, Coping with Errors in Impedance Spectra from Coated Metals, *Journal of Coatings. Technology*, **66**(834), pp. 59-61 (1994)
- W. S. Tait and K. A. Handrich, Cation Enhancement of Internally Coated Metal Container Corrosion Failure, *Corrosion*, **50**(5), pp. 373-377 (1994)
- W. S. Tait, K. A. Handrich, S. W. Tait, and J. W. Martin, Analyzing and Interpreting Electrochemical Impedance Spectroscopy Data from Internally Coated Steel Aerosol Containers, in ASTM **STP 1188**, pp. 428-437, American Society for Testing and Materials, Philadelphia, PA (1993)
- C. R. Aita and W. S. Tait, Nanocrystalline Aluminum Nitride: Growth by Sputter Deposition, Optical Absorption, and Corrosion Protection Behavior, *NanoStructured Materials*, **1**(4), pp. 269-282 (1992)
- W. S. Tait and C. R. Aita, Aluminum Nitride as a Corrosion Protection Coating for Steel: Self-sealing Porous Electrode Model, *Surface Engineering*, **7**(4), pp. 327-330 (1991)
- W. S. Tait and C. R. Aita, Modeling Corrosion Behavior of Aluminum and Aluminum Nitride Coated Steel, when Exposed to Oxygen-Free Aqueous Potassium Chloride, *Corrosion*, **46**(2), pp. 115-117 (1990)
- W. S. Tait and J. A. Maier, Predicting Results from Static Storage Tests on Internally Coated Metal Containers Using Electrochemical Impedance Spectroscopy Data, *Journal of Coating Technology*, **62**(781) pp. 41-44 (1990)

- W. S. Tait, Using Electrochemical Impedance Spectroscopy to study Corrosion Behavior of Internally Coated Metal Containers, Journal of Coating Technology **61**(768), pp. 57-61 (1989)
- W. S. Tait and J. A. Maier, Progress in Using Electrochemical Impedance Data to Predict Results from Static Storage Tests on Internally Coated Metal Containers, in **Advances in Corrosion Protection by Organic Coatings**, edited by J. D. Scantlebury and M. W. Kendig, **89-13**, pp. 251-258, The Electrochemical Society, Pennington, NJ (1989)
- W. S. Tait, C. O. Huber, B. C. Begnoche, J. R. Siettmann, and C. R. Aita, Al, Al-N, and AlN-coated Steel Corrosion Behavior in Oxygen-Free Potassium Chloride Solution, Journal of Vacuum Technology, **A6**(3), pp. 924-927, (May/June 1988)
- W. S. Tait, Use of Electrochemical Impedance to Evaluate Organic Coatings on Aerosol Containers, in **Corrosion Protection by Polymer Coatings**, edited by M. W. Kendig and H. Leidheiser Jr., **87-2**, pp. 229-239 (1987)
- W. S. Tait and J. A. Maier, A Novel Corrosion Test Cell for Predicting the Long-Term Corrosion Behavior of Metal Aerosol Containers, Corrosion **42**(10), pp. 622-628 (1986)
- W. S. Tait, Using Emulsion Particle Size Distribution to Optimize Emulsion Manufacturing Processes, Chemical Engineering Progress, **82**(5), p. 29 (1986)
- W. S. Tait, Effects of Physical Parameters on the Pitting Corrosion of Mild Steel Exposed to Oxygen Bearing, Low Total Dissolved Solids Waters, Corrosion **35**(7), pp. 296-300 (1979)
- W. S. Tait, Comparison of Potentiodynamically Determined Pitting Rates with Actual Pitting Rates for Mild Steel and Admiralty Brass in Oxygen Bearing Waters, Corrosion, **34**(6), pp. 214-217 (1978)
- R. R. Annand, H. M. Hilliard, and W. S. Tait, Factors in the Corrosivity of Seawater used for Secondary Petroleum Recovery, in ASTM **STP 641**, pp. 41-53, The American Society for Testing and Materials, Philadelphia, PA (1977)

NON-PEER REVIEWED JOURNALS

- W. S. Tait, Make Your Corrosion Data More Reliable, Corrosioneering, May 2002
- W. S. Tait, Increase Your Confidence in Corrosion Data, Materials Performance (March 2001)
- Increase your Confidence in Electrochemical Data with the Solartron 1281 Multiplexer, Solartron Application Note, September 1999

W. S. Tait, Aerosol Container Corrosion and Corrosion Testing: What is the State of the Art? Spray Technology and Marketing, September 1997.

W. S. Tait, J. A. Maier, and D. C. Liebe, Recent Developments in Predicting Corrosion Behavior of Aerosol Containers, Aerosol Age, **31**(5), p. 28 (1986)

INVITED PRESENTATIONS AT PROFESSIONAL SOCIETY MEETINGS AND CONFERENCES

Elements of a Comprehensive Aerosol Container Corrosion Prevention and Control Program,

Eastern Aerosol Association, Newark, NJ (October 2006)

Latin American Aerosol Congress, Buenos Aires, Argentina (September 2006)

Southern Aerosol Technical Association, Atlanta, GA (March 2006)

Midwest Aerosol Association, Chicago, IL (April 2006)

Using Electrochemical Corrosion Testing to Save Time on Long-term Static Storage Tests, the second North American Steel Packaging Conference, (October 2002)

Using Electrochemical Measurements to Accurately and Quickly Estimate Coating and Polymer Film Durability, the Federation of Societies for Coatings Technologies, Fall ICE Technical Convention (October 2002)

Aerosol Container Corrosion Prevention, Control and Measurement, SATA technical conference, Destin, Florida, October 5, 2001.

Nanolaminate Coatings: A New Way to Protect Metals and Alloys from Corrosion ASM International, Southeast Wisconsin Section, Milwaukee WI, April 10, 2001

An Introduction to Aerosol Container Corrosion, Corrosion Prevention and Control CSPA Workshop Aerosol Technology Workshop, Washington, DC, April 18-20, 2001

An Overview on Electrochemical Methods for Evaluating Coated Metal Performance, Forth Workshop on Quantitative Methods for Evaluation of Paint Coating Performance, Department of Navy, Naval Surface Warfare Center Carderock, West Bethesda MD, September 28-29, 1999

Steel Container Corrosion and Corrosion Testing: What is the State of the Art? American Iron and Steel Institute, North American Steel Packaging Conference. Chicago, IL, Oct. 20, 1998

An Overview on Electrochemical Methods for Evaluating Coated Metal Performance,
Third Workshop on Quantitative Methods for Evaluation of Paint Coating
Performance, Department of Navy, Naval Surface Warfare Center Carderock,
West Bethesda MD, October 20-21, 1997

Reliability Engineering: The Commonality between Airplanes, Light Bulbs, and Coated Steel, International Symposium on A Systems Approach to Service Life
Prediction of Organic Coatings, Breckenridge CO (September 14 - 19, 1997)

Aerosol Container Corrosion: A Brief Overview. Aerosol Industry Development
Association, Chicago IL (April 1997)

Where are We with Predicting Coated Metal Lifetimes? Gordon Research Conference on
Aqueous Corrosion, New London, NH (July 1996)

Using Reliability Statistics to Estimate Metal Container Failure Levels from Censored Tests, NACE Corrosion/96, Denver, CO (March 25-28, 1996)

One Laboratory's Experience Using Laminated Steel for Metal Packaging, Fall National
Electrochemical Society Meeting, Chicago, IL (October 13, 1995)

Using Electrochemical Impedance Spectroscopy to Measure Coated Metal Corrosion,
NACE Mid-America Corrosion Conference, Schaumburg IL (October 1-4, 1995)

A Discussion on the Reliability of Electrochemical Impedance Spectroscopy Data from Coated Metals, Spring Meeting of the American Chemical Society, Denver, CO
(April 18-23, 1993)

Everything You Wanted to Know about Electrochemical Impedance Spectroscopy; but were Afraid to Ask, EG&G Practical Applications of Electrochemical Corrosion
Techniques, New Orleans, LA (December 2-4, 1991)

Analyzing and Interpreting Electrochemical Impedance Spectroscopy Data from Internally Coated Steel Aerosol Containers, ASTM National meeting,
San Diego, CA (November 4, 1991)

Pitfalls Encountered when Analyzing Electrochemical Impedance Spectroscopy Data,
Southern Wisconsin section of the Electrochemical Society, Milwaukee WI
(October 31, 1991)

Electrochemical Impedance Spectroscopy: One Laboratory's Experience Using it to Predict Corrosion Behavior of Internally Coated Steel Containers, Steel Structures
Painting Council Coating Evaluation and Durability Conference, Pittsburgh, PA
(April 29-May 3, 1991)

Electrochemical Impedance Spectroscopy: One Laboratory's Experience using it to Predict Corrosion Behavior of Internally Coated Metal Containers, EG&G fifth Annual Corrosion Measurement Techniques symposium, St. Louis, MO (December 4, 1990)

The Effect of Cation Solution Size and Concentration on the Corrosion Behavior of Internally Coated Tinplated Steel Aerosol Containers, 64th Colloid and Surface Science Symposium, Bethlehem, PA (June 18-20, 1990)

Progress in Using Electrochemical Impedance Spectroscopy Data to Predict Results from Static Storage Tests on Internally Coated Metal Containers, Advances in Corrosion Protection by Organic Coatings symposium, Cambridge, England (April 10-14, 1989)

Using Electrochemical Impedance Spectroscopy to Study Corrosion Behavior of Internally Coated Metal Containers, EG&G Electrochemical Techniques for Corrosion Measurement symposium on Corrosion Measurement, San Francisco CA (December 12-14, 1988)

Modeling Corrosion Behavior of Organic Coated Metals with Electrochemical Impedance Spectroscopy: Application to Metal Packaging, Third Chemical Congress of North American Continent and 195th ACS Meeting, Toronto, Canada (June 5-11, 1988)

Aluminum Nitride Coated 1010 Mild Steel Corrosion Behavior in Oxygen-Free Potassium Chloride Solutions, 34th National Symposium of the American Vacuum Society, San Diego CA (Spring 1988)

Electrochemical Techniques in Corrosion Studies, Southern Wisconsin section of the Electrochemical Society, Sturtevant, WI (March 1987)

Corrosion Behavior of Aluminum Oxide Reactive RF Magnetron Sputter Coated Mild Steel in Potassium Chloride Solutions, NACE Corrosion/87, San Francisco, CA (March 1987)

Using Electrochemical Testing to Predict Long-Term Corrosion Behavior of Organic Coated and Uncoated Aerosol Containers, EG&G Electrochemical Techniques for Corrosion Measurement symposium on Corrosion Measurement, Chicago IL (November 20-21, 1986)

Using Electrochemical Testing to Evaluate Performance of Organic Coatings Used on Aerosol Containers, Fall Electrochemical Society Meeting, San Diego, CA (October 19-24, 1986)

CONFERENCE PROCEEDINGS AND ABSTRACTS

Using Electrochemical Corrosion Testing to Save Time on Long-term Static Storage Tests, the second North American Steel Packaging Conference, (October 2002)

Using Electrochemical Measurements to Accurately and Quickly Estimate Coating and Polymer Film Durability, the Federation of Societies for Coatings Technologies, Fall ICE Technical Convention (October 2002)

W. S. Tait and K. A. Handrich, A Discussion on the Role of Cations in Enhancing Internally Coated Metal Container Failure, Proc. 12th International Corrosion Congress, pp. 77-86, Houston, TX (September 19-24, 1993)

W. S. Tait, A Discussion on the Reliability of Electrochemical Impedance Spectroscopy Data from Coated Metals, in Proceedings of the ACS Division of Polymeric Materials: Science and Engineering, **68**, pp. 101-102 (1993)

W. S. Tait and K. A. Handrich, A Discussion of the Molecular Basis for Using Electrochemical Impedance Spectroscopy to Estimate Coating and Corrosion Parameters, Proc. Second International Symposium on Electrochemical Impedance Spectroscopy, Santa Barbara, CA (July 12-17, 1992)

R. S. Lillard, J. Kruger, P. J. Moran, and W. S. Tait, Coating Inspection by a Scanning Electrochemical Impedance Spectroscopy Technique, Proc. Second International Symposium on Electrochemical Impedance Spectroscopy, Santa Barbara, CA (July 12-17, 1992)

W. S. Tait, K. A. Handrich, and J. A. Maier, Electrochemical Impedance Spectroscopy: One Laboratory's Experience Using it to Predict Corrosion Behavior of Internally Coated Steel Containers, **SSPC 91-15**, pp. 161-182 (1991)

W. S. Tait, Modeling Corrosion Behavior of Organic Coated Metals with Electrochemical Impedance Spectroscopy: Application to Metal Packaging, in Proceedings of the ACS Division of Polymeric Materials: Science and Engineering, **58**, pp. 322-328 (1988)

LECTURES AND SEMINARS AT UNIVERSITIES

Useful Statistics? The University of Florida at Gainesville (March 1997)

Developing a Model for Predicting Failure Using Its Characteristics, The Pennsylvania State University (October 1996)

Metal Containers for Consumer Product Packaging: a Plethora of Corrosion Challenges, The Pennsylvania State University (September 1994)

A Discussion on the Role of Cations in Enhancing Internally Coated Metal Container Corrosion, University of Wisconsin-Milwaukee, Center for Surface Studies Seminar Series (April 1993)

Electrochemical Corrosion Testing in an Industrial Environment, University of Wisconsin-Madison, Principles of Electrochemical Engineering course (December 1989)

Using Electrochemical Impedance Spectroscopy to Study Corrosion of Organic Coated and Painted Metals, University of Wisconsin-Milwaukee, College of Engineering and Applied Science Noontime Seminar Series (May 1989)

The Engineer as a Professional Writer, University of Wisconsin-Parkside, Technical Writing course (May 1986)

SEMINARS AND PAPERS AT PROFESSIONAL SOCIETY MEETINGS AND CONFERENCES

Al, Al-N Alloy, and AlN-Steel Corrosion Behavior in Oxygen-Free KCL Solutions, (Co-authored with C. R. Aita, C. O. Huber, B. C. Begnoche, and J. R. Siettmann), abstract number 608, American Vacuum Society National Symposium (1987)

Using Electrochemical Testing and a Novel Corrosion Test Cell for Predicting Real Time Corrosion Behavior of Metal Aerosol Containers, Corrosion/86, paper number 269, New Orleans LA (1986)

Using Emulsion Particle Size Distribution to Optimize Emulsion Manufacturing Processes, American Institute of Chemical Engineers Fall National Meeting, Chicago IL (1985)

The Use of Potentiodynamic Scanning for Predicting Real Time Corrosion in Metal Aerosol Containers, paper number 126, Fourth International Conference on Packaging, East Lansing MI (1985)

Comparison of Potentiodynamically Determined Pitting Rates with Actual Pitting Rates for Mild Steel and Admiralty Brass in Oxygen Bearing Water, Corrosion/78, paper number 173, Houston TX (1978)

Effects of Physical Parameters on the Pitting Corrosion of Mild Steel in Low Total Dissolved Solids, Oxygen Bearing Water, Corrosion/78, paper number 175, Houston TX (1978)

PATENTS

- U. S. Patent 6,501,286: Multiple Reference Electrode Array For Measuring Open Circuit Potentials in Artificial Crevices
- U. S. Patent 4,720,382: Inhibiting the Corrosion of Hair Conditioning Compositions
- U. S. Patent 4,668,507: Corrosion Resistant Insecticidal Composition
- U. S. Patent 4,668,293: Phytate Corrosion Inhibitor System
- U. S. Patent 4,395,318: Pitting Corrosion Meter
- U. S. Patent 4,240,925: Pitting Corrosion Inhibitors
- U. S. Patent 4,175,054: Use of Low Molecular Weight Polymers in Formulation of De-emulsifier Chemicals

PROFESSIONAL CERTIFICATIONS, SOCIETY MEMBERSHIPS, AND ACTIVITIES IN PROFESSIONAL SOCIETIES

CERTIFICATIONS

National Association of Corrosion Engineers Corrosion Specialist (certification number 2651).

I am one of eighteen corrosion specialists in the world who are certified as a chemical treatment specialist (development of corrosion inhibitors)

SOCIETY MEMBERSHIPS

NACE International (formerly the National Association of Corrosion Engineers)

The Electrochemical Society

ASM International

Southern Aerosol Technical Association

Midwest Aerosol Association

Eastern Aerosol Association

ACTIVITIES IN PROFESSIONAL SOCIETIES

Peer-reviewer for:

- The Corrosion Journal
- Corrosion Science (British corrosion journal)
- Journal of Coatings Technology
- Journal of the Electrochemical Society
- American Society for Testing and Materials (special technical publications)
- Progress in Organic Coatings
- U. S. Environmental Protection Agency
- National Institute of Standards and Technology

Councilor for the Southern Wisconsin chapter of the Electrochemical Society (1989)

Chairperson for the S. C. Johnson & Son, R,D&E Symposium Series
(1986 through 1989)

National Association of Corrosion Engineers examination proctor (1989)

Chairperson for the Southern Wisconsin chapter of the Electrochemical Society (1988)

Vice-Chairperson for the Southern Wisconsin chapter of the Electrochemical
Society (1987)

Chairperson for the Modern Ceramic Materials symposium, at the Materials Research
Society Spring meeting, San Francisco CA (1985)

Exhibit B

plotted. Materials have been grouped under general classification headings according to the major base metal. Within each classification are a number of materials frequently considered to have comparably similar corrosion resistances. For example:

- a. In carbon steels, carbon content up to 0.30% is not considered to alter appreciably the corrosion rate.
- b. Silicon bronze, aluminum bronze, and tin bronze are considered to have similar corrosion resistances in most media, but it is recognized they can differ markedly in specific environments.
- c. In stainless steels, Types 302, 304, 304L, 321 and 347 are expected to have similar corrosion resistance and are grouped as 18Cr-8Ni austenitic stainless in the corrosion tables.

d. In aluminum alloys, the following types are expected to have equivalent corrosion resistance: 1100, 3003, 3004, 5052, 6061, 6062, and cast 43, B214, 356, and 406. No aluminum alloy containing over 1.0% copper should be considered to have corrosion resistance equal to these.

Thus where data on any of the above are shown in the data tables, other materials in the same group usually can be expected to perform in a like manner.

3. Concentration of Corrosives

Concentrations in all cases (except in certain solutions and gases, either desiccated or essentially so) are considered to be water dilutions of pure compounds. Although it is fully understood that small quantities of contaminants may have a profound effect on corrosion rates, this factor is not ordinarily taken into account in the tables, often because the specific contaminants are not reported in the references from which data are taken. In instances where a metal was designated as being unaffected by a chemical and no mention was made of concentration or temperature, the tables show the metal as satisfactory at the 100% line at room temperature. This indicates that the metal has a possible use and could be considered.

4. Temperature

Temperature may affect the corrosion rate through its effect on oxygen solubility and availability. As temperature rises, oxygen solubility in an aqueous solution decreases and at the boiling point most oxygen is removed. On the contrary, the diffusion rate of oxygen increases with temperature. The corrosion rate may increase with temperature to some maximum and then decreases to some low value at the boiling point.

Temperature also may affect corrosion through its effect on pH, with increasing temperature often resulting in decreasing pH.

Temperature also may affect corrosion rates through its effect on films. It may increase the solubility of protective corrosion products, as in the case of lead in hydrochloric acid. A change in temperature also may bring about changes in the physical nature or the chemical composition of corrosion products which may make them considerably more or less protective. The behavior of zinc in water is an example. Another effect of rising temperatures on films is caused by precipitation of protective coatings on metallic surfaces, as in waters containing calcium sulfate and calcium carbonate.

In solutions under pressure at temperatures above their normal boiling points, corrosion rates may increase quite rapidly with temperature, possibly because many of the factors (such as diffusion, which normally acts to limit corrosion) are no longer controlling. The limiting effect of diffusion also can be overcome by rapid movement.

The effect of heat flux on the corrosion rate must be recognized. Maintaining a liquid at a bulk temperature of 248 (120 C) in a vessel can produce no corrosion, whereas the same temperature on the heating side of a metal surface may result in catastrophic corrosion.

Temperatures are plotted in degrees Fahrenheit from 0 to 500 (-18 to 260 Celsius) on the vertical axis of the matrix shown on the fold-out page. This matrix makes up the data tables throughout the book.

5. Corrosion Rates

An arbitrary set of corrosion rates has been established for this survey to meet the requirements of instrument, design and maintenance engineers. (See the Key to Data Points on the fold-out page.) The ideal rating (denoted in the tables by a solid circle) has been assigned when corrosion is less than 2 mils (50 μm) per year. Many materials have this property and may be used for some pieces of equipment, although they may be ruled out for others because of other failings, such as contamination of product, brittleness, temperature limitations, unavailability in suitable form.

When this highest degree of corrosion cannot be indicated, a secondary rating (an open circle) representing less than 20 mils (508 μm) per year corrosion rate is used. In the development of this category, considerable difficulty has been encountered due to the various methods of reporting corrosion data. Materials reported as "recommended" or "completely resistant" may have corrosion rates less than 2 mils per year but without actual figures, they have been placed in the second category (20 mils per year) rather than the ideal one. For the majority in this category, the corrosion rates probably will be below 5 mils per year. The rating of 20 mils per year indicates those materials which normally would be specified where a corrosion allowance of 60 - 120 mils is added for protection against possible mild corrosion.

A third classification (an open square) is provided to indicate a corrosion rate between 20 and 50 mils (508 and 127 μm) per year. These materials can be used only in special cases where such a rate can be tolerated, but are not considered adequate for general plant construction.

The final rating (an X) is given where the corrosion rate is probably too high (over 50 mils per year) to merit consideration.

6. Additional Factors Influencing Corrosion Rates

There are many factors besides concentration and temperature which influence corrosion rates and, while they are often extremely important, it is impossible to list them all in a survey of this type. For example, velocity, aeration, heat flux, the presence of oxidizing agents, and other chemical contaminants can either increase or decrease the corrosion rate. The effect of galvanic coupling is also important in assessing the useful life of a piece of equipment and should be considered.

Welding is another factor which may influence service life. Aside from intergranular corrosion, which is discussed below, there are instances where as-deposited weld metal is attacked in preference to the base metal; conversely, there are occasions when the weldment is more resistant. Additionally, localized stresses due to welding often make zones adjacent to welds susceptible to stress corrosion cracking. For these reasons, selection of the correct welding material is as important as selection of the base material.

Many alloy systems show variations in corrosion resistance as a result of being heated or cooled in a certain way. It is important that fabrication and heat treatment are such that an alloy's corrosion resistance is not impaired if the fabricated part is intended for corrosive service. Generally the solution annealed condition is preferred, but the manufacturer of the alloy should be consulted for his recommendations.

Exhibit C

eral, therefore, a specific Galvanic Series exists for each environment, and the relative positions of metals in such series may vary from environment to environment.

The damage incurred by coupling of two metals depends not only on how far apart they are in the Galvanic Series (open-circuit potential difference) but also on their relative areas and the extent to which they are polarized (see p. 37). The potential difference of the polarized electrodes and the conductivity of the corrosive environment determine how much current flows between them.

LIQUID JUNCTION POTENTIALS

In addition to potential differences between two metals in an electrolyte, potential differences also arise whenever two solutions of different composition or concentration come into contact. The potential difference is called the liquid junction potential, and its sign and magnitude are determined by the relative mobility of ions and their concentration differences across the liquid junction. For example, in a junction formed between dilute and concentrated hydrochloric acid, H^+ ions move with greater velocity than Cl^- ions (mobility at infinite dilution = 36×10^{-4} and 7.9×10^{-4} cm/sec, respectively). Hence the dilute aqueous solution acquires a positive charge with respect to the concentrated solution. For potassium chloride, mobility of K^+ and Cl^- are similar, hence liquid junction potentials between dilute and concentrated KCl are small in comparison with HCl junctions. In fact, if the HCl solutions discussed previously are saturated with KCl, so that most of the current across the boundary is carried by K^+ and Cl^- ions, the liquid junction potential is very much decreased. Use of a saturated KCl solution whenever

TABLE 4
Characteristic Liquid Junction Potentials of Salt Solutions (MacInnes)

Electrolyte	Concentration	
	0.1 N	0.01 N
(-)HCl	35.65 mV	33.87 mV
KCl	8.87	8.20
NH_4Cl	6.92	6.89
NaCl	2.57	2.63
(+)LiCl	0.00	0.00

Exhibit D

TABLE 3
Galvanic Series in Seawater^a

<i>Active (Read down)</i>	
Magnesium	18-8 stainless steel, type 304 (active)
Magnesium alloys	18-8, 3% Mo stainless steel, type 316 (active)
Zinc	Lead
	Tin
Aluminum 5052H	Muntz metal
Aluminum 3004	Manganese bronze
Aluminum 3003	Naval brass
Aluminum 1100	
Aluminum 6053T	Nickel (active)
Alclad	76% Ni-16% Cr-7% Fe (Inconel) (active)
	Yellow brass
Cadmium	Aluminum bronze
	Red brass
Aluminum 2017T	Copper
	Silicon bronze
Aluminum 2024T	5% Zn-20% Ni, Bal. Cu (Ambrac)
	70% Cu-30% Ni
Mild steel	88% Cu-2% Zn-10% Sn (composition G-bronze)
Wrought iron	88% Cu-3% Zn-6.5% Sn-1.5% Pb (comp. M-bronze)
Cast iron	Nickel (passive)
Ni-Resist	76% Ni-16% Cr-7% Fe (Inconel) (passive)
13% Chromium stain- less steel, type 410	70% Ni-30% Cu (Monel)
(active)	Titanium
	18-8 stainless steel, type 304 (passive)
50-50 lead-tin solder	18-8, 3% Mo stainless steel, type 316 (passive)
<i>Noble (Read up)</i>	

^a F. L. LaQue, in *Corrosion Handbook*, p. 416, Wiley, New York, 1948.

are included. The Galvanic Series for metals in contact with seawater is given in Table 3. Note that some metals occupy two positions in the Galvanic Series, depending on whether they are active or passive, whereas in the Emf Series only the active positions are possible, since only in this state is true equilibrium attained. The passive state, to the contrary, represents a nonequilibrium state in which the metal, because of surface films, is no longer in normal equilibrium with its ions.

Although only one Emf Series exists, obviously there can be several Galvanic Series because of differing complexing tendencies of various environments or differences in tendency to form surface films. In gen-